RESEARCH AND TECHNOLOGY ADVISORY COUNCIL,

PANEL ON

ETY AND OPERATING SYSTEMS

RT OF MEETING

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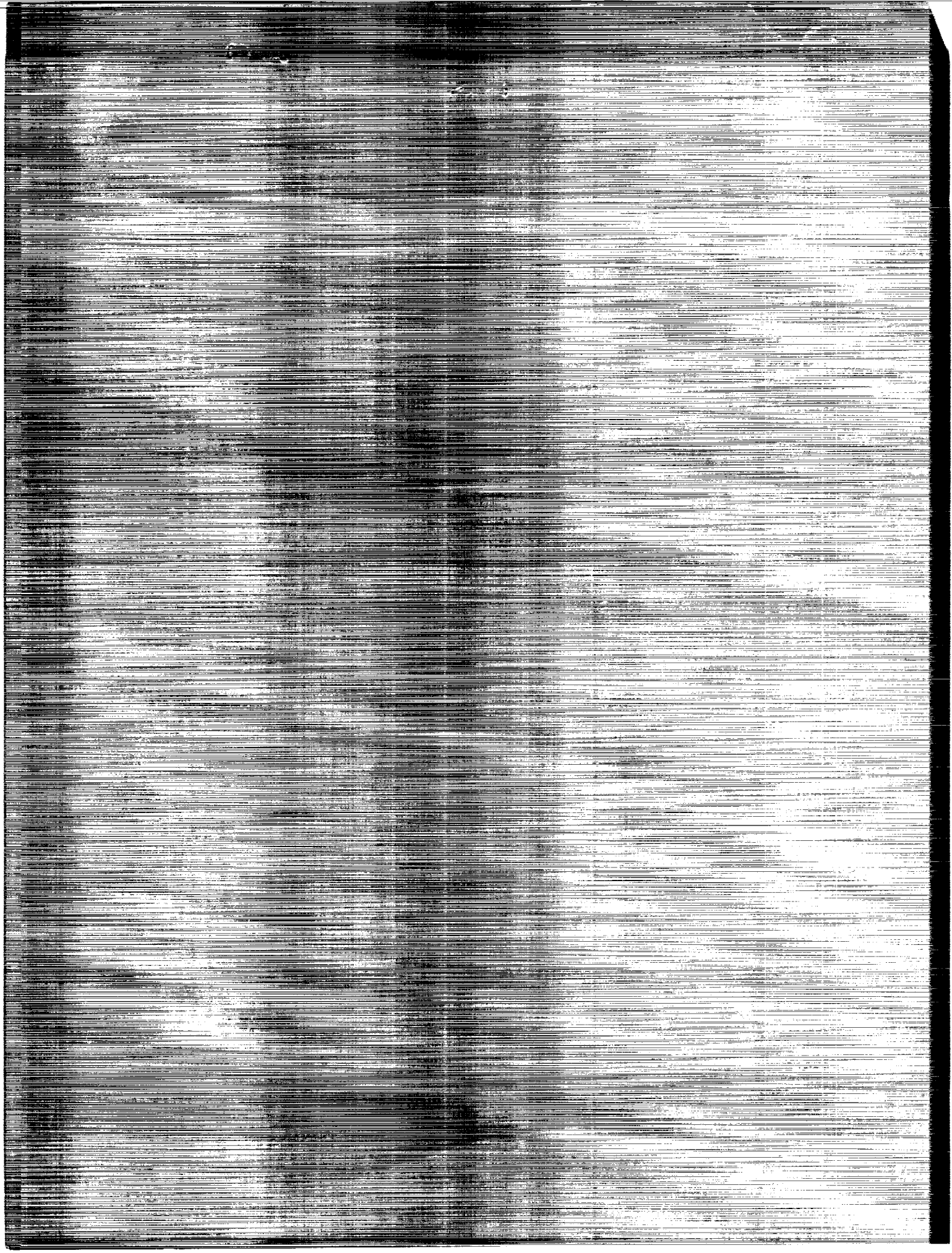

NASA RESEARCH AND TECHNOLOGY ADVISORY COUNCIL

PANEL ON AVIATION SAFETY AND OPERATING SYSTEMS

NASA DRYDEN FLIGHT RESEARCH CENTER

Edwards, California
May 11-13, 1976

The Spring, 1976 meeting of the NASA Research and Technology Advisory Council, Panel on Aviation Safety and Operating Systems took place at NASA's Dryden Flight Research Center on May 11-13, 1976. Chairman Franklin W. Kolk presided.

ROLL CALL

Members Present:

F. W. Kolk, Chairman	American Airlines
R. E. Black	Douglas Aircraft Co.
Capt. R. M. Boh	U. S. Navy
J. G. Borger	Pan American Airways
B. A. Cosgrove	Boeing Airplane Co.
C. C. Crawford	U. S. Army
Prof. R. Horonjeff	Univ. of California, Berkeley
B/Gen. J. H. Marshall	Air Force Systems Command
W. J. Quinlivan	Lockheed-California
Dr. S. N. Roscoe	Univ. of Illinois
R. W. Rummel	Trans World Airlines
G. P. Sallee	Pratt & Whitney Aircraft
Capt. L. L. Treece	United Airlines
K. E. Hodge, Executive Secretary	NASA Headquarters
J. H. Enders, Recording Secretary	NASA Headquarters

Ex-Officio Members Present:

E. G. Lyman	NASA Headquarters
R. W. Boswinkle	NASA LaRC
R. T. Duffy	NASA WFC
S. W. Gee	NASA DFRC

C. T. Snyder	NASA ARC
S. Weiss	NASA LeRC

Members Unable to Attend:

M. V. Huck	MVH Associates
M. V. Clarke	NTSB
J. Connally	NOAA
W. Magruder	Piedmont Airlines
C. F. von Kann	ATA
R. Gilstrap	ALPA

Invited Alternates Present:

R. S. Hersh	FAA
R. J. Phaneuf	ALPA
W. Sweet	NTSB

Guests:

R. L. Allison	Boeing Aircraft Co.
M. R. Barber	NASA - DFRC
J. Bull	NASA - ARC
B. Byrd	Delta Airlines, ATA
G. E. Cooper	NASA - ARC
J. Cayot	FAA - ARC
B. Y. Creer	NASA - ARC
F. Edwards	NASA - ARC
R. Foss	Lockheed California Co.
F. Fulton	NASA - DFRC
C. W. Harper	FAA - ARC
R. Lahr	ALPA
Dr. R. F. Landel	NASA - JPL
J. F. Lederer	USC Safety Center
E. McLean	NASA - LaRC
D. C. Nagel	NASA - ARC
B. A. Peterson	NASA - DFRC
H. A. Rediess	NASA - DFRC
M. F. Roscoe	FAA Headquarters
Dr. V. J. Rossow	NASA - ARC
C. Simpson	FAA Headquarters
H. Verstynen	FAA Headquarters
R. E. Zalesky	Lockheed California Co.

CHAIRMAN'S OPENING REMARKS AND WELCOME

Chairman Kolk convened the meeting, noting it as the first meeting of the expanded Panel. He expressed satisfaction that the Panel was now more appropriately constituted to address the operational and safety problems of the aviation system than it had been since the ill-advised reduction of membership made in 1971.

Mr. G. Griffen, newly-appointed Deputy Director of the Dryden Flight Research Center, welcomed the Panel and visitors on behalf of the Center Director and staff.

The Chairman charged the Panel with a renewed resolve to provide NASA with advice and guidance in the area of safety and operational problems research. Noting the improved effectiveness of the Advisory Council/Committee/Panel organization, the Chairman felt that improved channels of communication with policy-making levels of NASA exist and must be used by the Panel. He underscored the moral and ethical responsibilities of the advisory structure to provide wise counsel to NASA on its expenditure of public funds, so as to ensure a net gain to the taxpayer and an elimination of wasteful effort.

The Chairman also expressed gratification in the fact that many of the research progress briefings made to this Panel come from programs begun by NASA in response to past recommendations and resolutions of this Panel and its predecessor. He felt that, in the main, these programs are good, productive efforts, and should provide the basis for improved operational efficiencies and safety as aviation continues to develop.

Chairman Kolk introduced guest Marion F. Roscoe, newly-appointed FAA Assistant Administrator for Aviation Safety, who briefly described this new staff Office. The Office of Aviation Safety is an independent advisory function reporting directly to the FAA Administrator. Among its responsibilities are oversight of safety and safety-related operational

and research activities of the various FAA offices and the coordination of these activities with similar efforts in other government agencies and industry. The Office is the focal point for receipt and action on NTSB recommendations. While it is unlikely that one can totally escape a reactive mode of operation in safety improvement, Mr. Roscoe's intent is to, insofar as possible, provide anticipative action to head off potential safety problems.

The Chairman reaffirmed his personal goal as one of helping to continue the improvement of the relationship and teamwork between FAA and NASA. He noted that the area of aviation safety is especially important in this regard and offered Mr. Roscoe the Panel's support in this endeavor.

Chairman Kolk briefly traced the background of past safety activities, which have traditionally centered about operating problems. These problems often gave first indications of potential safety hazards and corrective action through research and engineering prevented serious accidents. Safety was largely concerned with "mechanical" safety, and the improvement of system reliability. In recent years, subtle changes have occurred in the character of risk as the mechanical reliability of the system improved dramatically. With system redundancy, equipment failure has become less determining as a safety factor, but system complexities have burgeoned, and human performance now emerges as an important, if not the pre-eminent, factor in maintaining the safety of the aviation system. Unlike mechanical systems, the human cannot presently be adequately modelled. Human decisions are critical to risk management, but the process is imperfectly understood. The Chairman exhorted NASA and FAA to work closely together on this critical problem of human performance in the system.

APPROVAL OF MINUTES

The minutes of the October 29-30, 1975, Panel meeting were approved as written.

EXECUTIVE SECRETARY'S REPORT

Executive Secretary Kenneth Hodge introduced the new Panel members and echoed the Chairman's gratification in the expanded membership. The military services, flight crew, weather, accident investigation points of view, as well as those of the three airframe manufacturers, are essential to the proper execution of Panel duties and responsibilities.

The Executive Secretary described key NASA organizational changes which have taken place since the previous meeting and noted that the NASA budget level is barely holding its own with inflation ($3.2B in FY 74 to $3.7B in FY 77).

Some program budget readjustments are taking place within the overall NASA budget, however, and as a case in point the Executive Secretary showed the downward trends of Space and Nuclear R&T funding as the Aeronautics R&T funding trend is increasing to $189M in FY 77 (from just over $100M in FY 71). The FY 77 budget plan calls for an increase of about 10% in aeronautics funding, and an increase of about 5% in the aeronautics R&T base. The FY 77 emphasis is on aircraft energy efficiency (ACEE) improvement which encompasses propulsion (40%), aerodynamics (20%), and composite materials and structures (40%). A secondary emphasis is placed upon environmental impact reduction by expanding the study of aircraft operational effects on the stratosphere.

The overall NASA manpower strength is about 23,000, with 3799 direct positions associated with Aeronautics R&T. The Chairman noted that this represents a loss of about fifty positions in FY 77, and expressed displeasure with the constant necessity to battle for more aeronautics positions.

The Chairman commented on the budget dollar levels and noted that the dollar amount does not always reflect the true level of effort or relative importance of a line item. However, the Panel must maintain cognizance of policies which impact the respective emphases placed on various research efforts and be aggressive in assisting NASA to develop its rationale in a balanced manner. The Panel meeting minutes

are a powerful tool of expressing consensus views of experts in an area; Chairmen's reports to the Council are more powerful. The Chairman stressed the point that this Panel is the only broadly-constituted advisory body to NASA that has a true overview of aeronautics. He will meet with the Council at its next meeting in July, when the views of this Panel can be made directly to Dr. Fletcher.

The Chairman discussed briefly the airlines' problem of ageing equipment. New airplane types are needed, but investment capital and technology are necessary ingredients to the production of a new airplane. If technology is available to make a sufficiently improved new airplane, investment capital will likely be easier to obtain also. This Panel can offer intelligent guidance to NASA to maximize the availability of new functional technology. The present airplanes in the fleet are approaching lifetimes of 50,000 - 60,000 hours, which exposes a new and relatively unfamiliar maintenance and inspection environment. The Kramer Committee report on fuel savings suggests new features which make sense for new airplanes, but less sense as retrofits. It does not appear to be desirable to simply build more new airframes of old design; we must incorporate those new features which will improve the economy and efficiency of the airplane. The Chairman expressed strong conviction that the NASA funding plans reflect a sense of urgency less than the airlines feel is necessary for industry survival. Panel member discussion endorsed this view and added that operational procedures should be sought to reduce non-productive flight time spent in traffic delay holding patterns, etc. While this is primarily an FAA problem, NASA should be encouraged to support the FAA in their effort to seek solutions.

RESEARCH STATUS REPORTS

Report of the Aviation Safety Reporting System (ASRS) Advisory Subcommittee: Mr. E. G. Lyman, Director of OAST's Man Vehicle Integration Division, briefly traced the background of the ASRS program, noting this Panel's past support and the Chairman's remarks concerning the importance of understanding human performance within the

system. In 1973 here at FRC, Mr. Lyman presented to this Panel some concepts of how to understand problems through incident reporting. In March 1974 at LeRC, he briefed the Panel on further development of a research program based on incident reporting, and the Panel supported this approach with a resolution. Introspective interviewing of flight crews was reported in 1975; the Panel endorsed the program with another resolution, and in May 1975, FAA formally asked NASA to undertake the design of a reporting system and to operate it for a limited period to insure "third party" immunity. NASA accepted this role, and has, with the help of an advisory subcommittee, designed and implemented the present ASRS. He introduced Mr. John B. Winant, President of the National Business Aircraft Association, and Chairman of the ASRS Advisory Subcommittee, who described the activities of the Subcommittee. Mr. Winant skillfully traced the development of the present ASRS operating procedures through the difficult and tortuous legal and vested interest thickets of the public and private sectors to arrive at a useful, nonpunitive, system which would encourage the voluntary reporting of system safety deficiencies. The risk of liability for civil penalties is a major deterrant to the free exchange of information which could ideally be used to prevent accidents, and the present system had to account for these risks, without interfering with the prosecution of criminal acts or accident investigation.

Two meetings of the subcommittee have taken place (December, 1975 and March 1976), where these problems were addressed and compromises were reached. The Freedom of Information Act and fear of incorrect reports as they might affect product liability resulted in a major revision to the system, along with the loss of otherwise potentially valuable information. Concerns were expressed about the possibility of prospective demand for report details by the legal community necessitated a severely reduced scope of report detail. While disappointing, the reduced scope of report detail was still felt to permit an adequate, highly responsive program to offer to the public for improvement of safety. The resulting program is corrective, rather than punitive, and is now on line, with reports beginning

to be received. The ASRS most significant aspect may be an improved understanding of the man-machine system inter-relationships.

Mr. Winant concluded his report by saying that Mr. Lyman, Drs. Billings and Lauber deserve every praise and support of this Panel and NASA for their dedicated efforts to make this system work in spite of tough obstacles along the way. Mr. Youngren of FAA has likewise worked hard and diligently against similar obstacles and also deserves credit for ASRS success. Mr. Winant closed by saying he welcomes Mr. Marion Roscoe's participation in this effort and his expressed determination to make use of its output.

Mr. Lyman added that a companion NASA research program to the ASRS will investigate the "why" of decision making and error. Beginning this effort is a full mission simulation program undertaken with Pan American. He announced that the planned NASA Conference on Aircraft Safety and Operating Problems Research at Langley in October, 1976, will include the first public report of this research which will address the human aspects of warning systems, mission simulations and interviews and analysis. FAA has recognized the ATC human factors problems as analogous to those of the flight deck, and plans to work on the controller human factors problems.

The Panel members expressed their pleasure with NASA's response to the past resolutions and to their response to FAA's request for assistance.

Report of Lewis Research Center: Mr. Solomon Weiss, Lewis Research Center Ex-Officio Member, acted as moderator for teleconference reports of three current Lewis Research Center programs.

Global Atmospheric Research Program (GARP): Mr. Robert Steinberg described the program Lewis is conducting in using commercial transport aircraft to collect meterological data in the tropics and southern hemisphere. The need for multilevel wind data in these regions has been surfaced by the World Meteorological Organization, since rawinsonde and satellite

wind data has proven to be inadequate. The long term goal of this program is to obtain regular multilevel windfield data on a global basis in near real-time. Commercial aircraft now flying routes in remote regions can supplement the present data base by carrying equipment to provide measurements of winds in these regions. Recent developments in commercial aviation through introduction of large wide-bodied aircraft with inertial navigation systems and space available for onboard data processing and storage have increased the attractiveness of this approach. When near real-time data are required, satellites may be employed as a relay link to central ground data analysis and distribution centers.

Mr. Steinberg explained the overall GARP program and how this effort fits within it. He described the instrument packages being used and the parameters measured. Using UTA, Air Afrique, Swissair, SAA, KLM, VIASA, the GATE program in 1974 successfully provided a considerable amount of data for nominal cost (OVER 50,000 samples in a 100 day program for $36,000), demonstrating the feasibility of this approach to obtaining met data. Using the SMS (Synchronous Meteorological Satellite) as a data relay link, the ASDAR (Aircraft to Satellite Data Relay) Program has as its objective the development of a low cost prototype data handling system to transmit met data from wide-body aircraft to the SMS for relay to a national met center.

Panel members expressed interest in this program, expressed concern over weight penalties imposed by the system and stressed the importance of making this data available in time to be of use to those who need it for flight planning purposes.

Low-Risk Failure Disk Program: Mr. Al Kaufman described techniques developed at Lewis to use new structural concepts to improve compressor and turbine disk life and to reduce the potential for catastrophic disk failure. This program is built on knowledge gained over the past few years' probram examining the fracture and impact mechanisms generated in disk failures. In FY 75, contracts were placed with GE and Pratt & Whitney to explore and analyze

disk design concepts which would provide stress path redundancies or failure in small fragments containable without resorting to unusual design methods. In FY 77, three of the promising concepts will be fabricated into disks for the ATEGG engine and in FY 78 they will be tested by the Navy at NAPTC and evaluated. The composite disk approach was abandoned because of the need for extensive fabrication development.

The Chairman expressed satisfaction that, after the several years spent on rotor burst containment research, this program is finally yielding some potential solutions to the disk failure problem, and called for a resolution supporting this effort to be prepared for the Panel's consideration.

Engine Lubricant Sump Fire Program: Mr. W. R. Loomis described the sump fire problems encountered in modern engine operation, over thirty-one incidents of sump fires or excessive heat in a bearing sump have occurred over a five year period in operation or ground test. The current push for higher performance efficiencies results in higher pressure ratios and temperatures which aggravate the sump fire situation. A preliminary study of the problem was completed several years ago which identified the parameters which influence a combustible mixture ratio and sump environment temperature. These include oil flow rate into the sump; oil inlet temperature; air leakage rate to the sump; air inlet temperature; shaft or bearing speed; ignition source and duration; sump volume and configuration; bearing housing, shaft, and seal temperature; and lubricant flammability. A bearing test rig has been modified to accommodate simulated sump fires, and renewed effort is directed at making a more definitive determination of the critical range of lubricant and hot air flow rates and other variables. From this study, Lewis will be able to determine the stoichiometric range of conditions where fires are likely to occur. Results/ conclusions reached to date include.

- Ignition - permitting conditions were found to exist heterogeneously within the sump, so that simple correlation of ignition within the sump with inlet flows and temperatures is not possible.

- Fires could be started at all air flow rates evaluated (4 to 28 SCFPM with air inlet temperatures as low as 875°F).

- Severity of fires increased directly as air flow rate.

- Air/oil mixture temperatures differ appreciably from the hot air inlet temperature.

- Air/oil mixture temperature varies inversely with oil flow rates.

- No fires could be ignited when the mixture temperature was below the flashpoint of the oil. The converse was not always true.

An extension to the present effort will perform spark ignition tests to evaluate the effectiveness of a novel sump baffle plate in producing an excessively rich oil environment adjacent to the bearing.

Additional rub ignition tests will be performed using improved honeycomb seal and rub shroud materials which may reduce rub temperatures. A computerized analysis of the test results is planned, in order to develop, concurrently with test procedures, a predictive method for determining conditions for sustained combustion in terms of critical flow and sump geometry.

Discussion of this program among the Panel members resulted in an endorsement of the Lewis oil sump fire research which is included at the end of these minutes.

Wake Vortex Alleviation Symposium: Dr. V. Rossow of Ames Research Center, summarized the major points presented during the Wake Vortex Alleviation Symposium held in Washington during February 24-25, 1976. (Executive Secretary's Note: Proceedings for this Symposium are in print and may be obtained through Mr. A. E. Gessow, Code RA, NASA HQ, Washington, DC 20546.) Mr. Marvin R. Barber, of Dryden Flight Research Center, described with movies and slides

the vortex alleviation flight tests at DFRC conducted to corroborate the ground facility tests at Langley and Ames. The results clearly show the influence of span-loading variation on vortex formation. The airline members questioned why NASA had not evaluated 25^{o} flap settings, rather than 30^{o}, since $25^{o}/25^{o}$ is normal flap setting in use. When shown that thrust effects alone appear to be effective for about 2 miles attenuation, the members asked if swirling the fan air flow had been looked at, and advocated NASA experimenting with swirling flow as a vortex counteractant. The Executive Secretary pointed out Lewis' success with scaling engine thrust and suggested that Langley and Ames seek Lewis advice on wind tunnel test techniques.

Some discussion took place concerning the criterion used to judge whether a vortex encounter was hazardous or not. The influence of such factors as ground proximity, vortex settling, crosswind, degree of turbulence, etc. must be judged along with pilot inputs to a vortex-induced roll motion. Thus, "hard" conclusions regarding establishment of a hazard boundary are elusive.

The Chairman pointed out that the successful techniques found so far influence the induced drag, which in turn, has an effect upon noise. This in turn may indeed affect the community acceptance of an aircraft equipped with vortex attenuation features.

The Panel members expressed satisfaction at the successes made to date in the wake vortex program, but enquired as to NASA's needs to ensure continued progress. It was pointed out that the process of transferring technology into the fleet normally requires five to ten years, and it is this problem of applying, not acquiring, technology that it so difficult. Additional cautions were offered that solutions found in the program and advertised to FAA and the industry do not unwittingly become design specific (e.g., the B-747SP has a different flap system than the B-747). Mr. Rummel observed that vortex alleviation is a fundamental problem which NASA has explored comprehensively. He felt that while the industry may be somewhat impatient, a deliberate approach is essential and he endorsed the program and its

continuance. Mr. Hersh noted that while vortex detection and warning systems may be suitable for certain applications, FAA is not presently prepared to install them on all runways.

The Panel members recognized that an increased allocation of manpower to this program would probably accelerate the rate of progress, but under present circumstances would have to be drawn from other programs which also enjoyed high priority. The Chairman called for a draft resolution reflecting the Panel's support of an accelerated effort on wake vortex alleviation work, to be considered during the discussion period later in the meeting.

Supersonic Cruise Aircraft Research (SCAR): Mr. F. Edward McLean, of Langley Research Center, briefed the Panel on the plans for the SCAR effort, noting that Dr. Lovelace had directed that each RTAC Panel and Committee be apprised of NASA's plans. The SCAR program expansion is one of several new initiatives being considered for possible implementation by NASA, and the necessity for a summer decision to present to OMB makes the timing critical.

The SCAR program augmentation consists of three elements: Propulsion, Aerodynamics and Structures. The major program expansion would occur in the Variable Cycle Engine (VCE) testbed work which would examine such concepts as duct burning, coannular nozzles, variable geometry fan, variable geometry turbine, and plug nozzles. An $11M increase is sought above the already-planned $13.1M for FY 78. Mr. McLean described the structural design methodology employed which utilizes a parallel iterative method. This technique results in fewer iterations and analyses, lower total cost, and more accurate results with updated airloads. The implications of the potential of various advanced technology on increased range for a hypothetical cruise vehicle was shown, as was anticipated progress in fuel efficiency and economics. A conceptual SCAR technology demonstrator airplane was described which would demonstrate mission capability with advanced technologies, and would likely eliminate or reduce prototype program costs for large supersonic aircraft.

In summary, Mr. McLean showed that the NASA SCAR Technology Program has identified potential for major technology "breakthroughs" in areas of propulsion, aerodynamics, structures, and materials. This technology, when integrated into practical supersonic cruise vehicles, can lead to range improvements of 30-40% over the 1971 U.S. SST, a 50% reduction in fuel usage compared to Concorde, total operating costs 50-60% those of Concorde, and noise levels below current standards. In order for these possibilities to be realized in a timely manner, a detailed program plan must be developed promptly. A SCAR symposium is planned in October at Langley.

The Chairman questioned the validity of SCAR claims for an approximate 20 dB noise reduction. Mr. McLean referred to flight test corroborations of small scale tests which encouraged further work. This work is yielding a new body of information on exhaust treatment of which researchers were previously unaware. Further discussion by the members revealed skeptical interest in the potentialities of this work.

High Speed Flight Testing: Mr. Fitzhugh Fulton, NASA Research Pilot at DFRC described flight testing with XB-70 and YF-12 aircraft which has provided verification data for predictive techniques, developed design criteria for the SCAR program, and provided test bed support for carrying experiments. Present test schedules showed the vast amount of useful work the YF-12 aircraft are performing and planned future work includes a "cold wall" experiment to obtain flight/wind tunnel corrective factors, an investigation of ventral fin loss flight dynamics effects, and a landing gear loads program.

Fairly substantial air temperature gradients have been observed; Mr. Fulton remarked that a 17-18^{o}F temperature difference in 8 seconds causes a high workload. The operation of the inlet also affects the phugoid. Altitude hold systems must be improved, and DFRC is also planning to examine different approaches to load alleviation.

Delayed Flap Program: Dr. John Bull, Ames Research Center provided a brief overview of NASA's Delayed Flap Program and CV990 flight test results. The objective of the program is to examine the delayed flap procedure for fuel/noise benefits, pilot and ATC acceptability, and avionics requirements. Dr. Bull described the typical approach geometry, the cockpit equipment, and crew procedures used in this approach, stressing relative simplicity and the lack of any substantive deviation from "normal" flight procedures. Since July 1975 when functional checkouts of equipment were performed, a series of flight tests have been conducted with substantial guest pilot and observer participation from airlines, manufacturers, airport management, and FAA. Various approach profiles were compared, showing fuel usage, time required, and areas enclosed by the 90EPNdB contour for conventional, reduced flap, two-segment, and delayed flap approaches. Guest pilot flight test evaluations were obtained which in the main indicated good acceptability for the delayed flap approach. Since a conventional ILS glide path is used, a conversion to a conventional approach is easy and quick, if desired.

There was some concern raised over the higher airspeeds in terms of ATC compatibility, but it was felt that measures were available to alleviate this concern. Fuel savings of 1-2% on a 750nm mission were demonstrated; the area enclosed by a 90EPNdB noise contour is 35% that obtained with a reduced flap approach.

Discussion of Dr. Bull's presentation centered about the need for additional data for currently-operational aircraft before placing too much confidence in the results obtained with the CV990. Dr. Bull pointed out that similar approaches were simulated for the B-727 with high confidence, and the DC-8 would likely behave similarly to the CV-990.

Mr. Drinkwater, research pilot at Ames Research Center, described the CV990 flight procedures and sequence of events as they appear in the cockpit. He stressed that the CV990 computer combination is an unusually flexible research facility with which one can demonstrate extremes. It allows judgment of which, if any, of a wide range of operational options, is feasible or practical. Mr. Drinkwater noted that there is no autothrottle on the CV990, but little

or no throttle manipulation is needed for energy management. There is no reason why the minimal equipment could not be installed in a wide body aircraft. The only ground-based facility needed is a co-located DME and glide slope.

Following these briefings, an opportunity was provided to interested Panel members for observing delayed flap approaches aboard the CV990, operating locally.

Mr. Tom Snyder, Ames Research Center Ex-Officio Member, summarized the program in terms of accomplishments to date, and described a potential follow-on program to further definitize the operational aspects of the delayed flap approach technique. He pointed out that there is no funding presently programmed for the follow-on effort, and a request for funding support must be based upon sound logic with general industry support if it is to be successful.

The FY 77 follow-on would seek to:

- o Determine minimum avionics retrofit requirements and costs
- o Investigate ATC compatibility
- o Investigate wake vortex hazards
- o Expand the evaluation of B-727 acceptability.

The results of this effort would be assessed and a decision would be made to terminate or continue. If the effort continued into FY 78, it would focus on necessary work leading to B-727 in-service flight evaluation in FY 79. It would involve design, fabrication, and installation of hardware; engineering flight tests; certification; and airline guest pilot evaluation.

Captain Treece observed that until the equipment involved can provide this energy management capability on every runway, its cost would be difficult to justify. This situation forces the FAA to consider the installation of a co-located VOR-DME at considerable expense. Mr. Snyder

responded that the Boeing systems cost study currently underway will provide a basis on which to address this question. Mr. Lyman observed that the CV990 as it is now equipped is an excellent research facility to work operational problems such as the delayed flap approach. The computer can construct a flight path of interest which can either be coupled through a command system into the autopilot or provide commands through annunciator for the crew roles can be examined as well as the flight dynamics aspects of advanced ATC concepts. He also pointed out the need for safety evaluations unconventional approaches, e.g., verification of manual entries into flight path computers, and a basis for monitoring computer performance, especially in a random or curved final approach situation.

The Chairman reflected on the transition from pistons to jets, noting that due to limitations on precise flight path control, the introduction of jets demanded a stabilized approach for safety purposes. The new terminal flight path concepts generally tend to erode this basis tenet of safety technique as they try to satisfy noise abatement, time-savings, and fuel savings requirements. The judgment of the pilot must be considered, since he is given the authority for ad hoc safety decisions. However, total reliance upon operational pilots' views where a proposed new operation is concerned ignores the airline management role in such decisions. In these types of programs, NASA should seek opinions and views from Flight Operations Department Heads, where a more balanced viewpoint will likely emerge. The Chairman noted the evolution of split federal jurisdiction over environmental issues, which provides non-aviation agencies with a means to impose requirements on operations which are not necessarily consistent with safety.

The view was also expressed that while noise and fuel savings benefits may be obtained, improved safety is the key to introducing a new technique. Data must be obtained in such form that its misuse and misinterpretation by aeronautically-naive organizations is avoided.

Additional discussion resulted in support of further effort as a research program, with caution urged in examining the operational safety and economics aspects with FAA, airline management and industry. The evolutionary nature of new technology implementation was stressed; irrespective of how technically feasible a new device or procedure may appear, other factors, such as overall safety, economics, correlation with overall systems operation, fleet-wide applicability, additional training or equipment investment, etc., must be considered in the final implementation decision. A demonstration of error tolerance is necessary to assess the margin of safety; NASA has not quantitatively evaluated the impact of the delayed flap approach on ATC, nor have they assessed the consequences of getting away from a dedicated DME. It was suggested that a potential user of the delayed flap approach might be able to make the decision with less effort than the projected NASA program. Several members expressed concern with lack of a more definite cost-benefit picture. Aircraft accidents are dominated by the crash landing problem out of the approach to landing. None of the several proposed new procedures appear to enhance the safety level of the stabilized approach. The pilot workload at critical times is increased. The margins needed in order to accommodate gross errors seem to be eroded. While noise reduction is a real requirement, such relief cannot be gained at the expense of safety. The members felt that complete support from the airline industry would be forthcoming if a positive increase in safety could be demonstrated, and any accompanying noise benefit would be welcome. The Chairman indicated that Congressman Wydler, to whom noise is a real concern and who had championed noise research, must feel let down, because no one has ever satisfactorily explained to him why research he has been sold has not worked. He then called for a draft resolution recommending continuation of the delayed flap effort, aimed at improving safety and developing a bridging logic between this program and the human factors program.

Visual Display Requirements: Mr. Del Nagel of Ames Research Center described a research simulator program aimed at determining how critical information (e. g., attitude, velocity, bearing, vertical flight path, etc.) is obtained by the pilot during visual flight in the terminal area.

One of the concerns centers about the fidelity of relevant visual cues reproduced in the simulator. Informed opinions of experts and performance measurements are used to measure the fidelity of the simulation. The development of psychophysical criteria, visual geometry criteria, visual information utilization criteria, cognitive load criteria,and subjective opinion criteria will be supported by this program. A decision theory model will be used to examine the landing in this program and expressed a desire to be kept informed of developments.

Proposed Upgrading of Langley Landing Impact Dynamics Facility: Via teleconference link, Mr. J. L. McCarty of Langley Research Center, described the background and capabilities of the Landing Loads Track (LLT), and reviewed accomplishments since the facility was activated in 1956. Manufacturers of tires, brakes, and airframes; military and civil operators; and regulative and investigative agencies have all benefited from programs which have defined landing gear design loads, impact dynamics, and tire/runway friction; determined braking and steering requirements; obtained shimmy data; evaluated landing wheel traction under all weather conditions; and have solved unique operational problems such as engine inlet spray ingestion and operation from unprepared airfields. Also, technical support to accident investigations to determine causes has been provided, and aircraft operational limitations in crosswinds and with surface contaminants have been determined. Recent milestones are: the initiation of high speed tire cornering and braking studies relating losses in steering capability with brake application; development of a rational system for detailed investigation of antiskid braking performance; evaluation of traction and wear characteristics of new ideas in aircraft tires(e.g., construction techniques, tread patterns, and tread materials); conduct of specialized tests requiring high translational speeds (e.g., free-rolling and braked tire behavior in soils, aircraft wing strikes on various designs for runway approach light towers, etc.).

The usefulness of this data and information grew from a speed, size, and weight capability representative of high-performance piston-engined transports; current aircraft

trends towards heavier weights, high cruising speed, and higher take-off speeds make the track's capabilities marginal at best, for investigating current and anticipated operational problems associated with large transport aircraft. Current track test speed capability is about 110K, which is below the touch down and take off speeds of current jet transport aircraft.

Langley is proposing an expansion of capability of the landing loads track by improving the propulsion and arrestment systems, extending the track by 600 feet, and by constructing a new high speed test carriage which would feature an open test bay to accommodate multi-wheel landing gear assemblies. This would permit an increase in test speed from 110K to 180K and a longer test duration.

The increased capability will permit investigation of the following problems representative of current concern:

- o Obtain braking and cornering force data above 110K
- o Research on tire damage at high speed.
- o Research to improve strut design, including active loads control
- o Examine high-speed behavior of single-and multi-wheel gears
- o More realistic simulation of landing and RTO conditions
- o Measurement of moving noise sources

Costs of upgrading the track are estimated at $11.0M in FY 79 when the facility improvement is planned. This would provide for a 600 ft. track extension, a new carriage, improved propulsion system and arresting gear, carriage storage building improvements, site development and other rehabilitation of existing facilities. The estimated cost of $11.0M in FY 79 dollars corresponds to $6.9M in FY 76 dollars.

There followed considerable discussion of present track capabilities and speculation as to requirements of future transport aircraft. While landing speeds are not expected to exceed current design landing speeds, take-off speeds are expected to increase. There was strong agreement that this facility has served the landing/ground operations problems research well in the past, and measures should be taken to expand facility capability to preserve the ability to investigate problems with heavier and faster aircraft of the present and future. Mr. Borger pointed out, in particular, that Concorde rotation speed is 190K, and high altitude field take-offs with conventional jets require 225K-rated tires. Wheel strength problems need to be investigated, rolling friction of blown tires should be defined, and brake squeal and chatter are pressing airline problems now. The Chairman noted also that the return on investment in this facility has been outstanding. Investigations have already been extended into areas not contemplated at the time of the inception of this facility. He called for a draft resolution supportive of track facility upgrading to be considered by the members later in the meeting.

Dryden Flight Research Center Report: Dr. H. Rediess, Director of Research at DFRC briefed the Panel on the Center's organization, mission and recent accomplishments. A film provided highlights of the broad scope of Center projects. Mr. R. Meyer described the YF-12 Ventral Fin Research project, which is employing analytical techniques, wind tunnel tests , and flight measurements to explore the loads imposed upon conventional and improved material ventral fins.

Mr. P. Loschke described the 3/8 scale F-15 RPRV project. The airplane with its ground support system, constitutes a complete research system, yet simple and of small size. The ground system is test pilot-oriented. Cost is reduced due to size, and a different approach to redundancies and testing is employed than if it were a manned system. The test envelope can be expanded with no diminution of safety, for example, in conducting both normal and inverted spin testing. A horizontal recovery technique has been developed, replacing the original parachute/helicopter aerial recovery.

Mr D. Reed described the mini-sniffer project, using a film to describe techniques used for launch, in-flight control, and recovery of the small craft. The hydrazine APV engine development carried out at JSC permits extremely high altitude operation of the vehicle. The craft can be used to measure turbulence, natural and man-made pollutants from ground level to substantially above 70,000 feet. The mini-sniffer can carry a 25lb. payload to 70,000 feet and cruise for one hour. It is expected to be ready to accommodate several payloads by early 1977.

FAA Simulation Activities at Ames Research Center: Mr. Jack Cayot, FAA Resident Director at NASA Ames Research Center, described the cooperative effort between FAA and NASA to jointly conduct simulation studies having as their aim the development of SST Airworthiness Standards. An FAA Engineering Office was established at Ames in March 1972, directed and funded by FAA's System Research and Development Service. Its function is to conduct R&D for the FAA operating services. Experience to date includes:

- o Emphasis on development of airworthiness standards for advanced aircraft, SST, and Powered Lift Transports
- o Define hazard boundaries for wake vortex encounters
- o Effects of Flight Control System failures on Aircraft Landing Qualities.

Current projects are concerned with:

- o Wind Shear (Fast time simulation study) effect on aircraft performance.
- o Simplification of current cockpit warning systems.
- o Exploratory program to define the role of simulation in aircraft certification process.
  - Examine FAR's for simulation potential

- Conduct concurrent simulation and flight tests

- Improve simulation technology.

A corollary program is aimed at developing methods to evaluate advanced flight control and digital avionics systems.

Mr. Lyman raised the problem of modelling the pilot appropriately and adequately. Mr. Cayot agreed, noting that flight tests corroborating simulation are providing confidence in the simulation concepts being used. General Marshall noted Air Force concern over the mid-air collision problem and their interest in a strobe light detector. He was informed that the current simulation effort did not include this problem. A number of other questions arose, regarding the extent to which one could rely upon simulation, and cautions were given that flight tests would not be eliminated until substantial confidence is gained in selected simulations. The Chairman asked if FAA had a rationale for identifying needs for research to head off problems before they become controversial issues due to accidents. The Secretary of Transportation has requested FAA to form an advisory committee to undertake a long-range research plan, including cockpit human factors, in an attempt to head off the reaction-mode of following, rather than anticipating, accidents. Additional discussion took place regarding how simulation can establish confidence in new control system concepts such as those identified by the so-called "Kramer Committee". It was generally agreed that full system simulation is vital to success, and that capability for simulating system failures is important. Fly-by-wire concepts would likely benefit greatly from good simulation, in establishing appropriate redundancies, etc. There followed some discussion of civil vs military exploitation of FBW control systems, noting that the F-8, F-16, and Concorde all employ FBW to varying extents.

The Panel concluded their discussion with a strong endorsement of the joint NASA-FAA Simulation effort, and called for an expanded effort to examine redundancy requirements of multiple path systems for aft c.g. control systems

Aviation Meteorology R&D Retreat: Mr. L. J. Ehrenberger, DFRC, described the NASA Aviation Meteorology R&D Retreat held at Wallops Flight Center, April 27-29, 1976. The purpose of the retreat was to informally discuss and exchange ideas between federal agencies sponsoring aviation meteorology R&D in order to reduce the fragmentation of work in this area resulting from budgetary and manpower problems. The ATA's Meteorology Committee Chairman was an invited participant, and government agencies present were: DOT, FAA, NTSB, NOAA-WPL, NOAA-NSSL, NSF(NCAR), and the NASA Centers (Hq., Ames, Dryden, Lewis Wallops, Langley, and Marshall). The retreat proved to be valuable as an exchange of information regarding current research effort and plans, as well as providing for a "brainstorming" session on R&D needs in aviation meteorology. In the Operations area, effective means of fog dispersal are still needed. More effective means of fog dispersal would improve safety and economy of operations; better methods for forecasting freezing rain and rain vs snow are still elusive. Airframe, antenna and engine nacelle centerbody anti-icing methods need improvement. It was unanimously agreed that better pilot education as to icing dangers would go a long ways toward preventing icing accidents. Ceiling and visibility measurement systems should be improved, and lightning protection for avionics and composite structures is needed.

Wind Shear and Turbulence information and understanding has improved greatly in the past few years, but further refinement and predictive capability is needed. Effective terminal area forecasting of severe weather necessitates better observational methods, and more understandable communications between pilot and forecaster.

The Chairman expressed the Panel's interest in continuing an effective program of meteorological R&D for aviation, and complimented NASA on sponsoring this retreat. The Panel endorsed NASA's aviation meteorology program and asked for an overall review of the program at the next meeting.

New Panel Organization and Terms of Reference: Panel discussion commenced with the Chairman reflecting that the new Panel provides a change of pace as we start functioning in a manner similar to the previous RTAC Committee on Operating Problems. Panel members discussed a meeting format

wherein we could treat safety and operational systems items individually versus a style where safety is not treated as a business by itself but is treated adequately in all Panel deliberations and activities.

Mr Lederer introduced a short discussion of risk management, a discipline which goes beyond safety as usually envisioned, i.e. risk management includes reliability, quality, economics, politics, etc., as well as safety. The Chairman acknowledged that one can calculate the total risks, find the dominant risk, establish acceptable hazard levels, etc.; risks need to be ordered and also evaluated from an economic viewpoint.

The Chairman concluded that the sense of the Panel members, as regards Panel operations under the expanded charter, was to conduct an integrated program, "wearing only one hat", with emphasis on safety varied as required.

The Chairman reviewed the RTAC process for the benefit of new members, explaining how Panel recommendations, resolutions, etc. are carried by him to Council meetings, and how the major issues are then carried by the Council to discussions with the NASA Administrator and other top NASA officials.

Fiscal Year 1978 Program Planning: NASA planning for FY 78 new starts and program additions in aeronautics was reviewed by the Executive Secretary. The planning, now well underway, involves development of advocacy statements and brief program plans which will be utilized in preparation of the NASA FY 78 Budget Request. The aeronautical advocacy themes are:

1. Aircraft Energy Efficiency/Conventional Takeoff and Landing Technology (ACEE/CTOL)

2. Short Haul/STOL

3. Supersonic Cruise Technology

4. Helicopters

5. High-performance VTOL

6. General Aviation Technology

In addition, a package of R&T Base items over the OAST financial guidelines is being prepared.

To prepare advocacy statements and develop program plans, "Theme Teams" have been formed from Headquarters and Center personnel and in some cases include members from other agencies. Review of "Theme Team" efforts has been made in depth by advisory groups comprised of selected RTAC Committee and Panel members, and other consultants. In addition, the various RTAC Committees and Panels are being briefed on the overall FY 78 Program Advocacy/Theme development effort and will be presented the final result at a later date.

Energy Crisis Related Problems: Mr. Lederer quoted a newspaper article which predicted severe curtailment of general aviation flying within the next ten years, and a return to natural rubber products (i,e. no neoprene) because of reduced availability of petroleum and its derivative products. He felt that NASA should be looking at the impact of returning to usage of natural rubber in tires, fuel control components, hoses, fuel cells, etc. Considerable Panel discussion ensued, with views ranging from the political hazards of accepting the dire prediction, to asking the ASEB Alternate Fuels Panel to consider the impact of a return to natural rubber. The Panel consensus was that they were not unmindful of the potential problems from a severe and prolonged fuel shortage and NASA might consider some appropriate exploratory research if a return to natural rubber begins to look more probable.

ASRDI Changes: Mr. Weiss described how recent organizational changes at Lewis had affected operations of the Aerospace Safety Research and Data Institute. First, the Data Bank which had never been adequately staffed since its inception at Lewis is in the process of being transfered to the NASA Headquarters Office of Systems Management, where bibliographic services would be more generally available to users through the NASA RECON (REmote CONsole) system. Formerly-available

consultation services on safety matters is not a part of the services provided by the organization maintaining the Data Bank.

Another impact of the Lewis organizational changes is that ASRDI per se has ceased to exist and the Center's safety R&D will be reduced in scope i.e. to be consistent with the propulsion systems charter of the Center.

The Chairman suggested that the ASRDI demise stems from the lack in recent years of a safety-dedicated Advisory Panel in NASA. The present PASOS should identify safety R&T areas for Lewis (under its narrowed safety research support capability) and reflect their concern that things are being allowed to fall through the cracks because program offices lack control (or at least major influence) on Center manpower.

Although some opinions were expressed that ASRDI should be a function operated out of NASA Headquarters, Mr. Lederer (former NASA Director of Safety) recalled that after ASRDI was set up at Lewis, he was asked to bring it to Washington, but demurred because he felt it would function more efficiently at a NASA Center. Chairman Kolk concluded the ASRDI discussion by stating that he and the Panel would search for "the right kind of oil" to apply to the present situation to restore the safety R&T capability which has apparently been lost through recent Lewis or other Center actions.

Panel Resolutions

At this point Chairman Kolk received written resolutions and endorsements which had been drafted by several Panel members in follow-up to the prior days' discussion. After further discussion over wording and other editorial changes, the following three resolutions and two ensorsements were presented by the Panel to NASA:

PANEL ON AVIATION SAFETY AND OPERATING SYSTEMS

RESOLUTION OF UPGRADING OF LANDING LOADS TRACK AT LANGLEY RESEARCH CENTER

WHEREAS, the Landing Loads Track at the Langley Research Center has been used for more than two decades to produce impressive research results in many areas including landing gear dynamics, slush drag, hydroplaning, pavement grooving, tire cornering and braking, antiskid braking, tire wear, tire behavior in soils, air cushion gear deployment, and hydrofoils, and

WHEREAS, additional research in these and related areas is required from standpoints of safety, operations, and design, including such areas as spray ingestion, wheel shimmy, breakage of wheels, landing with flat tires, evaluation of tire recap characteristics, take off loads, and characteristics of unconventional landing gears, and

WHEREAS, the needs of aircraft design have increasingly exceeded with time the capabilities of the facility and these capabilities are inadequate to accommodate much of the testing requirements.

NOW THEREFORE BE IT RESOLVED THAT:

The RTAC, Panel on Aviation Safety and Operating Systems recommends that the facility capabilities be upgraded and

extended, and that this upgrading include consideration for sufficiently high test speeds, including those representative of takeoff conditions, sufficiently long test durations, and accommodation of sufficiently wide ranges of test specimens and kinds of tests appropriate to present and projected research requirements.

PANEL ON AVIATION SAFETY AND OPERATING SYSTEMS

RESOLUTION ON TURBINE ENGINE DISK FAILURE RESEARCH

WHEREAS gas turbine engine disk failures continue to be a major problem inherent to turbine engines, and

WHEREAS research is needed to develop practical means of preventing catastrophic disk failures, and

WHEREAS the disk failure analysis and design work at NASA-Lewis is the first conceptual re-examination of disk design in some time.

NOW THEREFORE BE IT RESOLVED:

that the Panel supports the ongoing NASA-Lewis research on design concepts to reduce the hazards associated with disk failure, and suggests that a program of broader scope and greater extent would be more appropriate to the serious nature of the disk failure hazard.

PANEL ON AVIATION SAFETY AND OPERATING SYSTEMS

RESEARCH ON WAKE VORTEX MINIMIZATION RESEARCH

WHEREAS the wake vortex problem is creating a significant impact on the nation's airport capacity and

WHEREAS the wake vortex presents a potential safety hazard when appropriate aircraft separation distances are not observed and

WHEREAS NASA research on minimizing wake vortices has producted significant results which now need to be exploited to assess their practical application to airline operations in the national airspace system and

WHEREAS applicability of B-747 research results alone cannot safely be made to other aircraft models by generalization, and

WHEREAS noise, fuel consumption, landing distance, user cost, and other system impacts are not well known,

NOW THEREFORE BE IT RESOLVED:

That the Panel commend NASA for the fine basic research on vortex minimization which has been accomplished to date, and

BE IT FURTHER RESOLVED:

that NASA be encouraged to increase their efforts in order to accelerate the assessment of applicability of wake vortex minimization techniques and concepts to the airline operating environment. Progress is apparently being limited principally by lack of assigning sufficient NASA in-house manpower to this vital area of research.

PANEL ON AVIATION SAFETY AND OPERATING SYSTEMS

ENDORSEMENT OF DELAYED FLAP APPROACH PROCEDURES FOR NOISE ABATEMENT

The results of the Ames program on reducing noise and conserving fuel through refinements to operational flight procedures have shown evidence that significant noise and fuel reduction benefits may be achievable with the delayed flap approach technique. However, continued research appears necessary in order to provide information on the compatibility of the delayed flap procedure with the ATC system and its acceptability to airline Flight Operations Management. An examination of the cost and technical risks of system implementation should be continued with the objective of minimizing the complexity of the onboard system and eliminating the requirement of the collocated DME. A critical element is the requirement for an analysis defining the relative safety associated with such procedures. It is essential that any proposed noise abatement flight procedures provide a level of safety equal to or better than current approach procedures.

The Panel therefore endorses the program for continued research as outlined, (subject to review of safety analysis findings before undertaking the B-727 avionics retrofit and flight evaluation phases) and further suggests that NASA-Ames strengthen its ties and coordination with the FAA and airline representatives.

PANEL ON AVIATION SAFETY AND OPERATING SYSTEMS

ENDORSEMENT ON OIL SUMP FIRE RESEARCH

The Panel endorses the ongoing lubricant sump fire research program at NASA Lewis. Bearing lubricant sump fires are being experienced in today's high-bypass ratio engines. It is believed that projected new engines will be even more susceptible to this type of hazard because of higher temperatures and pressures. The Panel supports the expansion of the current programs to insure that all significant variables in such fires are identified and are systematically evaluated. The objective of this research should be to establish design criteria which would ensure that sump fires will not occur.

Questions Posed to Panel in Advance

The Executive Secretary asked Panel members for comments, reactions, reports, etc. related to three topical questions which were mailed to them before the meeting.

1. Looking ahead to the eventuality of higher altitude flight for cruise efficiency and high speed cruise, is there additional research or development required in the radiation hazards area, or is the current level of knowledge and technology adequate?

Discussion followed which covered radiation data obtained from the space program, supported Concorde's radiation monitoring system, and allowed as how the subject matter had been researched to death in the preparation of SST environmental impact statements. The Chairman summarized the Panel view that no responsible person feels that there is a radiation problem at present or in the forseeable future.

Mr. Black expressed concern over the potentially adverse effects on passengers from rapid decompression above 40 to 50 thousand feet altitude, if the passenger is unable to quickly acquire supplemental/emergency oxygen.

Mr. Borger recalled that early GASP data had shown higher ozone levels in the cabin than had been previously recognized, and asked for a progress report on GASP findings at the next Panel meeting. He noted that the 747SP at light weight could operate at flight level 450, but extensive high-altitude data-gathering should be accomplished with Concorde aircraft in scheduled operations. Ozone levels vary considerably on a seasonal, diurnal, and geographical basis and these recognized variations must be kept in mind.

Chairman Kolk concluded that there is lots of information around, but it has not been systematically collected and analyzed in the aeronautical area. Someone should pull it all together in an unspectacular way so that we have a firmer basis on which to judge the realities of potential problems.

2. What are the users' evaluations of the NASA technical reporting system? Are we adequately conveying results of recent research to industry? How do you rate report quality? Does the Scientific and Technical Abstract Reports (STAR) retrieval system satisfy industry needs? How should our reporting system be improved?

Members' discussion was generally complimentary on report quality, although the lag in getting reports (once work was completed) was considered too long. Some members asserted that when you want to find something out, you usually call or visit someone in NASA or elsewhere who can help you or steer you to the right person. In other words, the "old boy network" is commonly used. The OAST newsletter was cited as a good medium and particularly useful to those receiving it (which includes all RTAC Panel and Committee members) because technical contacts are identified for each technology item reported.

Several members recalled difficulty in obtaining copies of "old" NASA or NACA reports and wondered whether reprints or reissues could be made of some of the classics.

Mr. Quinlivan suggested that the NASA RECON system be made available to external users who have compatible computer equipment.

Those who had availed themselves of the STAR topical abstracts were satisfied with the service. The Executive Secretary reminded the Panel of their eligibility for STAR services and agreed to provide application forms for the new members.

3. NASA's effort in fuel conservation is limited to technology improvement and exploration of improved terminal area operating techniques. This Panel criticized earlier NASA efforts to look at the total flight profile. We have some recent indication that routine airline operations do not strongly emphasize uniform fuel-saving operational practices. If this is accurate information, is it because of lack of technology which NASA should address?

Panel consensus was nearly unanimous that adequate technology is available. In short-haul segments (e.g. LGA-DCA) canned flight plans are used because the pilot doesn't have opportunity to explore other profile options because of the close confines of ATC. It was recognized, however, that FAA has made ATC improvements for energy conservation and continues to work the problem. The airline operator view in particular was that ATC problems are not with management but with the controllers... who often show a lack of flexibility which could be a reflection of strong union ties. Reduced ATC delays (or the ability to predict delays) are the results most urgently needed.

Captain Treece noted that more accurate aircraft fuel quantity systems would foster more efficient operations because the flight crew would not be so inclined to carry "pocket fuel" to compensate for system inaccuracies. It was not known whether the life cycle cost of a more accurate gauging system would be recovered through savings from tankering less fuel.

Concluding Remarks

The Executive Secretary advised Panel members that the next meeting will be scheduled for October 20 and 21, at the Langley Research Center, immediately following the NASA Aircraft Safety and Operating Problems Conference at Langley.

In adjourning the meeting, Chairman Kolk expressed his appreciation to old and new members alike for their participation and constructive remarks during this first meeting of the expanded Panel. The meeting was adjourned at 11:20 a.m.

Respectfully submitted:

John H. Enders
Recording Secretary

Concur:

Kenneth E. Hodge
Executive Secretary